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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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SYSTEM FOR OPTIMISING THE PRODUCTION PERFORMANCE OF A MILK PRODUCING ANIMAL HERD

FIELD OF INVENTION

The present invention relates generally to a system and a method for optimising the production performance of a milk producing animal herd. More specifically, it relates to detection of the physiological condition of milking animals such as cows.

TECHNICAL BACKGROUND AND PRIOR ART

It is known to survey the physiological condition of milking animals, such as cows. It is also known to gather data from individual milking animals, including health data, feeding data and breeding data such as genetic data. A known procedure is every month to collect milk samples from individual milking animals, and send the samples to a central laboratory for chemical analysis, and thereby deriving information on the milk quality as well as the health condition of each individual milking animal.

As a consequence, several dairy herd improvement associations (DHIA) collect, evaluate and distribute data relating to e.g. milk yield, milk quality and mastitis (inflammation of the mammary gland caused by micro-organisms). DHIAs can be found in most important milk producing countries. Through these data available at the DHIAs, the dairy farmers can select the best milking animals for breeding, make appropriate adjustments to feeding schemes, control health and optimise the milk production.

Today, however, the process of collecting such data is cumbersome and requires a lot of manpower, and typically the milk samples are collected manually and are transported to central laboratories where they are analysed. Consequently, milk from each milking animal is typically only analysed 6-12 times per year. Thus, it is not possible for the individual farmer to take immediate action and e.g. implement feeding scheme adjustments or initiate prophylactic actions or antibiotic treatments to combat e.g. mastitis.

Thus, it is highly desirable to provide the dairy farmer with instant access to data indicating the immediate physiological condition of each individual milking animal and

thereby having the possibility of taking instantaneous action on the basis of these data, and improve the overall performance of the production system, including animal welfare and protection of the environment against pollution with animal waste, and with that the farm earnings.

As an example, it is a problem that e.g. a cow may suffer from subclinical mastitis or other diseases for several weeks before it is detected. An early detecting of mastitis and other diseases is highly desirable as e.g. mastitis has an important impact on the overall dairy farm business economy. Another well known problem is to find the optimal time for a insemination. Thus, it is economically important for individual farmers to have instant access to updated data relating to heat and pregnancy in order to determine the optimal insemination time and control of pregnancy. Additionally, physiological conditions relating to feeding such as ketosis, a metabolic disorder, and the overall metabolic balance (such as the protein balance in the rumen) of the milking animal, are conditions which have an important economical influence on the farm economics.

Thus, automatic monitoring systems are needed. A presentation of research objectives for the development of such monitoring and sensing systems for monitoring the health of dairy cows has been given by Mottram (Livestock Production Science, 1997; 48:209-217).

Furthermore, US 5,873,323 discloses a method of milking animals automatically while determining whether the milking animal is ill or in oestrus. Sensors are placed in the milking conduit system leading from the teat cups. The sensors measures a variety of parameters including milk flow, milk temperature, vacuum and electric conductivity of the milk (mastitis detection). Additionally, data relating to milk yield, the quantity of food consumed by the animal and the frequency that each animal enters a milking compartment are measured. The data obtained by the measurements are provided to a computer. The computer compares the data with similar data from immediately preceding selected periods of time, whereby a progressive average of the relevant data is available and compared for each animal. The data received for ill animals or animals in oestrus differ from those received from healthy and non-oestrus animals, whereby the computer through the data processing may indicate which animals are and are not healthy or in oestrus.

The present inventors have now developed a system for optimising the production performance of a milk producing animal herd which is based on the finding that frequent and continuous measurements of compounds indicative of and relating to the physiological condition of individual milking animals, may advantageously be applied in such a system in order to improve the overall production performance of the milking animal herd and hence the overall earning capacity of the dairy farm.

Especially it has been found that by combining parameters relating to mastitis, protein balance, ketosis and state in oestrus cycle in a system according to the invention it has become possible to improve the dairy farmers income per milking animal, and thereby the profit and earning capacity of a dairy farm.

Thus, the combination of the above parameters has been found to provide far more detailed and reliable information resulting in better knowledge of the overall physiological condition of milking animals, such as e.g. metabolic disorders and reproductional status, as compared to the data obtained by prior art systems. Furthermore, it is contemplated that the combination of the above parameters in most circumstances will have a synergistic effect. This synergistic effect may be measured as an effect increasing the sum of the individual effect of each of the individual parameters applied. Thus, it is contemplated that the synergistic effect obtained by the combination of the parameters will provide a more detailed and precise information about the milking animal as compared to the use of individual parameters.

Additionally, the new system includes an internal and/or external database whereby there is provided the possibility of storing and analysing a set of continuous data recorded regularly, such as every day. Accordingly, newly recorded data can be compared to historical data. Thus, there is provided the possibility to provide and depict a detailed and more reliable status of a milking animal as compared to presently available systems which typically only provides data which is not directly correlated to the specific physiological conditions, and thus only provide data with a limited predictive value.

Furthermore, an external database such as a knowledge centre has been found to provide basis for highly improved analysis as compared to prior art systems. In addition, the system according to the invention provides the possibility of a direct connection to

external advisors, and thus the new system provides quicker action for remedying diseases and/or malfunctions than is provided by presently known systems.

SUMMARY OF THE INVENTION

Accordingly, the invention pertains in a first aspect to a system for optimising the production performance of a milk producing animal herd, the system comprising

(a) means for collecting at a milking site milk samples from individual members of said herd,

(b) analysing means that, in the presence in said milk samples of at least one compound indicative of the physiological condition of the herd member, generates a detectable signal or detectable signals,

(c) signal detection means for recording the character of said signal(s) and for processing the signals to provide a set of data descriptive of the physiological condition for said individual herd members, and

(d) means for data storage of said set of data descriptive of the physiological condition for said individual herd members, and

(e) data output means.

In a further aspect, the invention relates to a method for optimising the production performance of a milk producing animal herd, the method comprising the steps of

(i) collecting at a milking site milk samples from individual members of said herd,

(ii) contacting said samples with analysis means that, in the presence in the milk of at least one compound indicative of the physiological condition of the herd member, generate a detectable signal or detectable signals,

(iii) recording in a signal detection means the character of said signal(s) to provide a set of analytical data indicative of the presence and/or amount of said compound for said individual herd members,

(iv) processing said analytical data in a data processing means to provide a set of data descriptive of the physiological condition for said individual herd members, and

(v) on the basis of said set of data descriptive of the physiological condition, taking appropriate steps, to the extent required, to improve the production performance and/or physiological condition of said herd members.

In a still further aspect the invention relates to the use of system in accordance with the invention.

DETAILED DISCLOSURE OF THE INVENTION

In view of the currently increasing size of farms with respect to the number of milking animals on a single farm, it is pertinent to provide improved herd management assistance systems and analysing means for larger dairy farms, such as farms having about 100 milking animals or more. Such systems are highly needed in order to improve the overall production performance such as milk yield and milk quality by e.g. improving the health of the herd through improvement of the health management, and thereby improve the dairy farmers income per cow.

Accordingly, one major objective of the present invention is to provide a system for optimising the production performance of a milk producing animal herd which is based on the detection or measurement of compounds in the milk which are indicative of the physiological condition of the individual herd member. The term "production performance" as used herein, is intended to mean the production performance in its broadest aspect. Thus, included in this term is milk production, including quantity and quality, and reproductive performance, e.g. the number of offspring per milking animal.

In the present context the term "milk producing animal herd" is intended to mean any herd comprising milk producing animals such as cows, goats, camels, buffaloes and sheep.

As will be clear from the following description, the system can be adapted to comprise the measurement of a wide range of compounds present in milk from a milking animal herd member which is indicative of the physiological condition of the milking animal. Accordingly, in the present context the term "compound indicative of the physiological condition of the herd member" indicates any suitable compound which during specific physiological conditions of the herd member is present in the milk of the milking animal. More specifically, the term "compound" as used herein indicates any suitable organic or inorganic compound as well as biological material such as micro-organisms, blood cells or somatic cells. The term "micro-organism" is being used herein in its broadest sense to describe any organism that can occur as separate cells, including bacterial cells, fungal cells, yeast cells and viruses. Organic compounds includes hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, carboxylic acids and their derivatives, amines, organic sulfur compounds, heterocyclic compounds, organohalogen compounds, coloured compounds and dyes, carbohydrates, amino acids, peptides, proteins and lipids.

In the present context the term "physiological condition" is intended to mean any physiological condition of the milking animal which may affect the overall production performance of the milking animal. Such physiological conditions may as examples be diseases including mastitis, digestive tract function such as protein balance in the rumen, metabolic performance such as ketosis, and state in reproduction cycle.

The system according to the invention comprises sampling means for collecting at a milking site milk samples from individual members of a milking animal herd. Preferably, the sampling means is the physical connection between the milking points and the analysing means. The function of the sampler is to collect milk samples to be analysed at the appropriate time during the milking process and subsequently to present the samples to the analysing means. It is contemplated that the sampling means advantageously may be adapted to perform sampling from individual glands of each individual herd member.

The milking site may be part of an automatic milking system for freely moving milking animals, carrying identification means, such as earmarks, or strips which may be electronically detected. In a further embodiment the milking site is one of many milking sites in a herringbone milking system. In the broadest aspect of this invention other kinds of milking sites may be applied, e.g., rotating or parallel parlours.

As mentioned above, the system according to the invention comprises analysing means which in the presence in the milk samples of at least one compound which is indicative of the physiological condition of the herd member, generates a detectable signal or several detectable signals. It will be appreciated that any suitable means for performing such analysis may be applied in accordance with the invention. Relevant examples of such analysing means includes enzymatic based assays, immunologically based assays, biosensors, spectrometric assays, wet chemistry assays, sequential injection analysis and flow injection analysis assays which are suitable for analysing the presence of the compounds. Preferably, the analysing means are designed to perform quantitative measurements. In one useful embodiment the analysing means may be in the form of test strips (also known as dry sticks).

Additionally, the system comprises signal detection means for recording the character of the signals from the analysing means. Such characters could e.g. be in the form of intensity, frequency, colour, number etc.

Furthermore, the system comprises means for processing the obtained signals and thereby provide a set of data which is descriptive of the physiological condition for the individual herd member. The means for signal processing are preferably in the form of a computer program which is executable on a computer system and designed to translate and to process the obtained signals and to carry out analysis of the obtained data in order to reveal physiological conditions such as mastitis, protein balance, ketosis and state in reproduction cycle.

Such analysis can be carried out in many ways, e.g. by comparing with recent data from the specific milking animal, and/or calculated mean values based on similar data from the specific herd, and/or from recent and/or earlier obtained data from the specific milking animal.

In accordance with the invention the system comprises means for data storage of the obtained set of data which is descriptive of the physiological condition for the individual herd member. For permanent storage of data, magnetic and optical media such as tapes, disks, and CD-ROMs may be applied. Accordingly, the measurement data for each milking animal are kept in the data storage allowing for analysis of periodically changes,

and allowing to compare data for specific milking animals as well as allowing for comparing data from different milking animals in order to provide a better identification of any abnormality or deviation. Furthermore, the system comprises data output means for delivering or presenting the obtained and processed data to the user, typically by print, visual and/or auditive means including telephones such as mobile telephones.

For the purpose of data analysis, the system according to the invention comprise an internal database and/or an external database having multiple data relating to previous analysis of samples for the presence of compounds which are indicative of the physiological condition of milk producing animal herd members. It will be appreciated, that in order to support these databases, software such as database management systems (DBMS) is required in order to handle the storage and retrieval of data, and in order to provide the user with commands to query and update the database. Relevant examples of such database management systems include hierarchical and relational database management systems. The database management systems is preferably stored on a memory device and is executable for query on a computer system.

In an advantageous embodiment the multiple data stored in the internal database and/or the external database are data selected from the location of the milking site, data for time of sample collection, data identifying the individual herd members from which samples were collected, analytical data indicative of the physiological condition of the herd member, and historical data of the individual herd member. In an advantageous embodiment the external database comprises data descriptive of the physiological condition collected from similar individual members of one ore more corresponding milk producing animal herd(s).

Thus, it is contemplated that when a plurality of data obtained from individual herds are transmitted and stored in the external database, this external or central database will after a period of time contain a great plurality of organised data for many milking animals from many areas. Statistical processing of the great number of data is expected to allow for continuos improvements of early diagnosis of abnormal physiological conditions of milking animals such as cows. An important advantage is that such external and central database will obtain data from a great number of cows all over a specific district - e.g. a whole country - even the whole world. The great number of data will make a basis for statistical processing of the data in order to reveal new information. As a special advantage any

tendency to epidemic illness among e.g. cows is expected to be easier to reveal and recognise. It is contemplated that the communication to and from the external or central database is via the internet.

It will be appreciated that the internal and external databases may comprise further data and information. Such additional data and information may be data representing diagnostic parameters, physiological parameters, physiological knowledge and data representing advises and recommendations relating to actions to be taken regarding specific results from the analysis.

In one aspect, the database management system is capable of comparing real time analytical data received from the signal detection means with data stored in the internal database and/or an external database and, based thereupon, transmitting an instruction message. Such an instruction message can e.g. be a message indicating that a specific herd member is ready for insemination, indicating that a specific herd member is in need for mastitis treatment or indicating that a specific herd member is in need for feeding scheme adjustment. The recipient of the instruction message may e.g. be a specified specialist such as a farmer, a veterinarian and a farmer consultant.

In a further embodiment the instruction message may be sent from the system, e.g. as a digital signal, to the milking system, such as a an automatic milking system. Thus, it will be possible divert milk of low quality, such as mastitic milk, away from the ordinary high quality milk. Additionally, it is contemplated that the system according to the invention may comprise means, including "smart gates", adapted to receive an instruction message and as response hereto direct selected animals to selected sites so as to allow for the above mentioned treatments or actions.

In one embodiment the compound indicative of the physiological condition of the herd member is a compound selected from compounds indicative of mastitis, protein balance, ketosis and state in reproduction cycle.

In the present context the term "mastitis" is to be understood as an inflammatory reaction of the mammary gland. Mastitis is often characterised by the cause of the disease which may be infectious, traumatic or toxic. When mastitis occurs, the intramammary tissue is damaged, followed by an increased permeability between the blood and milk

compartments, resulting in changes in milk composition. Sub clinical mastitis can only be detected by laboratory tests whereas clinical mastitis can be detected by clinical examination of the milk and/or the udder. The pathogens most often found in connection with mastitis are bacteria such as *Escherichia coli*, *Staphylococcus aureus*, *Micrococcus* spp., *Streptococcus uberis*, *Streptococcus agalactiae* and *Streptococcus dysgalactiae*.

Mastitis is the most costly of the production diseases in the dairy industry. For example, annual losses from mastitis cost US dairy producers more than 2 billion dollars annually. Decreased milk production, discarded milk, reduced raw milk quality and higher culling rates are the most important economic consequences of both sub-clinical and clinical mastitis. However, public health, product quality and shelf life, animal care, and consumer perception provide additional economic incentives to control mastitis. Risk of mastitis is positively correlated to milk yield and despite much effort little improvement in reduction of incidence of mastitis, if any, has occurred during the last couple of decades. Thus, it is of major importance for the dairy farmer to have an early, or more preferably, an instant indication of mastitis, including sub clinical mastitis, in order to minimise the economical losses and animal welfare problems caused by this disease.

Several compounds are known to be indicative of mastitis. Such compounds includes somatic cells, enzymes, proteins, lipids, minerals and trace elements. Accordingly, compounds such as fatty acids, total whey protein, κ-casein, immunoglobulins, proteose-peptones, serum albumin, lactoferrin, and minerals such as sodium, chloride, iron and copper may be useful in connection with the present invention. However, in certain embodiments, enzymes may be applied as compounds indicative of mastitis. Representative examples of such enzymes are catalase, lactate dehydrogenase, alkaline phosphatase, acid phosphatase, carboxylesterase, arylesterase, β-glucuronidase, Lactoperoxidase, lipase, lysozyme, xanthine oxidase, plasmin and beta-N-acetylhexosaminidase (NAGase).

In a presently preferred embodiment the compound which is indicative of mastitis is beta-N-acetylhexosaminidase (NAGase). NAGase is an intracellular, lysosomal enzyme (E.C. 3.2.1.52), belonging to a group of enzymes called glycosidases. NAGase is involved in glycoprotein catabolism and is present in plasma. The concentration of NAGase in plasma is typically 11 to 20 times of that found in normal milk and two to four times that of mastitic milk. The function of NAGase in mammary secretions is presently not known.

The feeding of milking animals is an important economical aspect for optimising the production performance. A typical problem in present dairy farming is that the milking animals are not optimally fed. Thus, high yielding milking animals are often offered the same fodder mixture as low yielding milking animals. One important aspect in relation to the composition of the feed for milking animals is that the raw protein content of the feed should be optimised in order to improve the overall raw protein balance of the milking animal. In the present context the term "protein balance" is used to designate the ratio between the amount of protein which is taken up by the milking animal and used for milk and tissue production, and the amount of urea excreted from the milking animal.

It is known to use the content of urea in milk, as a measurement for indicating the protein balance of a milking animal, i.e. as an indicator of the milking animal utilisation of dietary nitrogen. The urea concentration in the blood of milking animals vary and the urea concentrations will be affected by e.g. protein intake and urinary excretion. If the milking animal consumes feed with a content of raw protein that is too high for microbial conversion in the rumen, this will result in higher blood urea levels. As blood urea is freely diffusable into milk, changes in blood urea levels will cause a corresponding change in milk urea level normally denoted milk urea nitrogen (MUN).

Accordingly, milk urea nitrogen (MUN) can be used in accordance with the invention as an indicator e.g. for optimising a feeding scheme or for pointing out possibilities for changing the composition of the feed. Thus, MUN measurements can be used in order to precisely and instantaneously meeting the nitrogen requirements of each individual milking animal. Additionally, MUN measurements can aid the dairy farmer to e.g. lower feed costs, to increase the overall milk protein yield, and to minimise nitrogen excretion into the environment.

As was mentioned above, the metabolic performance of the milking animal is particularly relevant for the overall production performance of each individual milking animal, and hence the entire herd. Ketosis is a metabolic disorder affecting the metabolic performance which is often found in dairy animals such as cows. The cause is lack of available energy for the mammary gland in early lactation. When milking animals such as cows are affected, they typically lose weight and produce less milk. Dietary adjustment are needed to prevent and treat the disorder. The disorder is characterised by elevated levels of

ketone bodies in the tissues and body fluids, including blood milk and urine. In the present context "ketone bodies" includes compounds such as acetoacetate, beta-hydroxy-butyrate (BHB) and acetone.

In order to optimise the production performance of a milk producing animal herd, it is pertinent to closely monitor the state in reproduction cycle of each individual animal in order to decide the optimum time for insemination, i.e. to determine the optimum reception time in the cycle. However, it is difficult to observe and closely monitor a large herd and hence automatic and frequent detection methods are needed. Especially it can be difficult to identify the first receptable heat after calving and lactation start for cows between 40 and 65 days after calving.

"State in reproduction cycle" is used herein to designate the different periods in the sexual cycle of female mammals during which they are in pro-oestrus, oestrus (in heat), di-oestrus and pregnant. Compounds which may be applied in accordance with the invention for indicating reproductional state may be a hormone such as progesterone. Progesterone is a steroid hormone produced by the corpus luteum in the ovary and the placenta in all mammals.

It will be appreciated that it may not be necessary to measure each compound indicative of the physiological condition with the same frequency. Thus, as an example, NaGase may advantageously be measured frequently, e.g. once per day, whereas it may only be necessary to measure milk urea nitrogen twice a week. Progesterone may be measured in a period when heat is expected such as 3 times per week. Further, progesterone may be measured in order to determine or confirm pregnancy.

As mentioned above, in a further aspect the invention provides a method for optimising the production performance of a milk producing animal herd comprising the steps of (i) collecting at a milking site milk samples from individual members of the herd, (ii) contacting said samples with analysis means that, in the presence in the milk of at least one compound indicative of the physiological condition of the herd member, generate a detectable signal or detectable signals, (iii) recording in a signal detection means the character of said signal(s) to provide a set of analytical data indicative of the presence and/or amount of said compound for said individual herd members, (iv) processing said analytical data in a data processing means to provide a set of data descriptive of the

physiological condition for said individual herd members, and (v) on the basis of said set of data descriptive of the physiological condition, taking appropriate steps, (automatically or by man) to the extent required, to improve the production performance and/or physiological condition of the herd members.

In one useful embodiment the collection and analysis of the milk samples from the individual members of the herd is performed at least once per day, including at least twice per day such as at least three times per day.

The invention will be further illustrated by means of the following non-limiting examples and the drawings wherein:

Fig. 1 shows the system arranged at a milking site,
Fig. 2 shows an embodiment of a data handling system for collecting, storing and processing data,
Fig. 3 shows a plurality of farmers coupled to a central system,
Fig. 4 shows one embodiment of an analyser according to the invention, and
Fig. 5 shows a second embodiment of an analyser according to the invention.

EXAMPLES

Example 1

Analysing equipment arranged at a milking site

As an example, Fig. 1 shows the analysing equipment for analysing compounds indicative of the physiological condition of the milking animals arranged at a milking site in connection with a sampler. As can be seen from the figure, the sampler is the physical connection between the milking points and the analysing equipment. The function of the sampler is to collect milk samples to be analysed at an appropriate time during the milking process.

The milking site may be part of an automatic milking system for freely moving cows, carrying identification means, such as earmarks, or strips which may be electronically detected. In a further embodiment the milking site is one of many milking sites in a

herringbone milking system. In the broadest aspect of this invention other kinds of milking sites may be applied, e.g., rotating or parallel parlours. As can also be seen from Fig. 1, the analysing equipment may be combined with existing milking control system performing complementary measurements such as milk volume, milk flow and temperature measurements.

At the milking site the identification of the cow is read and stored electronically. One or more samples are extracted from the milk flow. Preferably sample(s) are extracted from at least one - preferably specifically identified - quarter of the udder. An advantageous alternative may be to extract samples from at least two quarters of one udder in order to compare the measurements on samples from the two quarters.

Example 2

Data handling system for collecting, storing and processing data

Figure 2 illustrates one embodiment of the present invention. As can be seen from the example in Fig. 2, the system consist of a data system, comprising a local arrangement at the farm including milk sample extraction means, analysis equipment, data collection and processing, data storage, and further processing and transmission. As can be seen from Fig. 2, the processed data may be transmitted via a communication channel, such as the internet, to external databases. In the present example the transmitted data are received and stored in an external database at a knowledge centre, such as e.g. DHIA (National Dairy Herd Improvement Association), a scientific centre or a university. The knowledge centre is accessible to a plurality of advisors, consultants, veterinarians, scientists etc. As can be seen from Fig. 2 the knowledge database is accessible to advisors, consultants etc. through the internet. As is further illustrated on Fig. 3, the data in the external database at the knowledge centre may be collected from a number of farms.

Example 3

Chemical analysis equipment

As mentioned above, various appropriate chemical analysis equipment may be applied in order to perform the chemical analysis of the compounds indicative of the physiological condition of the milk producing animal.

Fig. 4 illustrates one example of such suitable chemical analysis equipment adapted to carry out the invention. Test strips or dry sticks **1** adapted to indicate the presence or amount of one or more of the desired compounds are stored in separate cartridges **2** holding the test strips. A test strip **3** is released from the cartridge to a conveyor belt **4**. The conveyor belt advances the test strip towards a peristaltic pump **5**. The inlet of peristaltic pump **6** is connected with the milk pipe line receiving milk from the milking equipment. As indicated in Fig. **4**, the peristaltic pump **5** withdraw a small sample from the milk pipe line, thereby transferring of few drops to the test strip **7**. A chemical reaction takes place and the test strip is analysed by a detector or test reader **8**, such as a CCD camera or other photometric equipment, having a signal output port connected to a data collecting and processing device.

Fig. 5 illustrates another embodiment of an analyser adapted to carry out the invention. Again, test strips or dry sticks **1** adapted to indicate the presence or amount of one or more of the desired compounds are arranged on a carrier tape **2** covered by a sealing tape **3**. The tape is arranged on a spool **4**. The sealing tape **3** is removed by rewinding on a second spool **5** shortly before the stick is exposed to the milk sample. A fast loop **6** extracts a fraction of the milk from the milk line. A valve **7** opens for a short time releasing a few drops of milk onto a test strip **1**. A funnel **8** located beneath the tape is arranged to receive the excess milk as waste. The tape is moved forward whereby the test strips **1** after having received a few drops of milk are exposed to the detector **9**, and subsequently rewinded on the spool **10**. The detector can be a CCD camera or other photometric equipment having a signal output port connected to a data collecting and processing device. In a presently preferred embodiment the test strips or sticks on the tape are arranged to comprise 4 sensing areas: Acetone or BHB (beta-hydroxy-butyrate), progesterone, NAGase (beta-N-acetylhexosaminidase) and urea (milk urea nitrogen). It is however also contemplated to apply a tape having only one or two different sensing areas, such as sensing areas for the two most often applied compounds for indicating the

physiological condition of the milk producing animal. Such compounds are e.g. compounds indicating mastitis and milk urea nitrogen.

CLAIMS

1. A system for optimising the production performance of a milk producing animal herd, the system comprising

(a) means for collecting at a milking site milk samples from individual members of said herd,

(b) analysing means that, in the presence in said milk samples of at least one compound indicative of the physiological condition of the herd member, generates a detectable signal or detectable signals,

(c) signal detection means for recording the character of said signal(s) and for processing the signals to provide a set of data descriptive of the physiological condition for said individual herd members,

(d) means for data storage of said set of data descriptive of the physiological condition for said individual herd members, and

(e) data output means.

2. A system according to claim 1 wherein the at least one compound indicative of the physiological condition of the herd member is a compound selected from the group consisting of compounds indicative of mastitis, protein balance, ketosis and state in reproduction cycle.

3. A system according to claim to claim 2 wherein the compound indicative of mastitis is beta-N-acetylhexosaminidase (NAGase) E.C. 3.2.1.52.

4. A system according to claim 2 wherein the compound indicative of protein balance is milk urea nitrogen (MUN).

5. A system according to claim 2 wherein the compound indicative of ketosis is a ketone body.

6. A system according to claim 5 wherein the ketone body is selected from the group consisting of acetoacetate, beta-hydroxy-butyrate and acetone.

7. A system according to claim 2 wherein the compound indicative of the state in reproduction cycle is a hormone indicating oestrus.

8. A system according to claim 7 wherein the hormone is progesterone.

9. A system according to claim 1 comprising an internal database and/or an external database having multiple data relating to previous analysis of samples for the presence of compounds indicative of the physiological condition of the milk producing herd members.

10. A system according to claim 9 wherein the such multiple data being selected from the group consisting of location of the milking site, data for time of sample collection, data identifying the individual herd members from which samples were collected, analytical data indicative of the physiological condition of the herd member, and historical data of the individual herd member.

11. A system according to claim 9 were the database management system is capable of comparing real time analytical data received from the signal detection means with data stored in the internal database and/or an external database and, based thereupon, transmitting an instruction message.

12. A system according to claim 11 wherein the external database comprises data descriptive of the physiological condition collected from similar individual members of a corresponding milk producing animal herd.

13. A system according to claim 11 wherein the instruction message is indicating that a specific herd member is ready for insemination

14. A system according to claim 11 wherein the instruction message is indicating that a specific herd member is in need for mastitis treatment.

15. A system according to claim 11 wherein the instruction message is indicating that a specific herd member is in need for feeding scheme adjustment.

16. A system according to claim 11 wherein the recipient of the instruction message is a specified specialist including a farmer, a veterinarian and a farmer consultant.

17. A system according to claim 1 wherein the analysing means are selected from the group consisting of enzymatic based assays, immunologically based assays, biosensors, spectrometric and flow injection analysis.

18. A method for optimising the production performance of a milk producing animal herd comprising the steps of

(i) collecting at a milking site milk samples from individual members of said herd,

(ii) contacting said samples with analysis means that, in the presence in the milk of at least one compound indicative of the physiological condition of the herd member, generate a detectable signal or detectable signals,

(iii) recording in a signal detection means the character of said signal(s) to provide a set of analytical data indicative of the presence and/or amount of said compound for said individual herd members,

(iv) processing said analytical data in a data processing means to provide a set of data descriptive of the physiological condition for said individual herd members, and

(v) on the basis of said set of data descriptive of the physiological condition, taking appropriate steps, to the extent required, to improve the production performance and/or physiological condition of said herd members.

19. A method according to claim 18 wherein the at least one compound indicative of the physiological condition of the herd member is a compound selected from the group consisting of compounds indicative of mastitis, protein balance, ketosis and state in oestrus cycle.

20. A method according to claim 19 wherein the compound indicative of mastitis is beta-N-acetylhexosaminidase (NAGase) E.C. 3.2.1.52.

21. A method according to claim 18 wherein the compound indicative of protein balance is milk urea nitrogen (MUN).

22. A method according to claim 21 wherein the compound indicative of ketosis is a ketone body.

23. A method according to claim 22 wherein the ketone body is selected from the group consisting of acetoacetate, beta-hydroxy-butyrate and acetone.

24. A method according to claim 18 wherein the compound indicative of the state in reproduction cycle is a hormone indicative of oestrus.

25. A method according to claim 24 wherein the hormone is progesterone.

26. A method according to claim 1 wherein the collection and analysis of the milk samples from individual members of the herd is performed at least once per day, including at least twice per day such as at least three times per day.

26. Use of a system according to any of claims 1-17.

ABSTRACT

A system for optimising the production performance of a milk producing animal herd is provided. The system comprises milk sampling means, analysing means that in the presence of compounds indicative of the physiological condition of the herd member, generates a detectable signal. Specific compounds are compounds indicative of mastitis, including beta-N-acetylhexosaminidase (NAGase) E.C. 3.2.1.52, protein balance, including milk urea nitrogen (MUN), ketosis, including acetoacetate, beta-hydroxy-butyrate and acetone and state in reproduction cycle, including progesterone. Furthermore the system comprises signal detection means for recording and processing the signals, means for data storage and data output means. Additionally there is provided a method for optimising the production performance of a milk producing animal herd.

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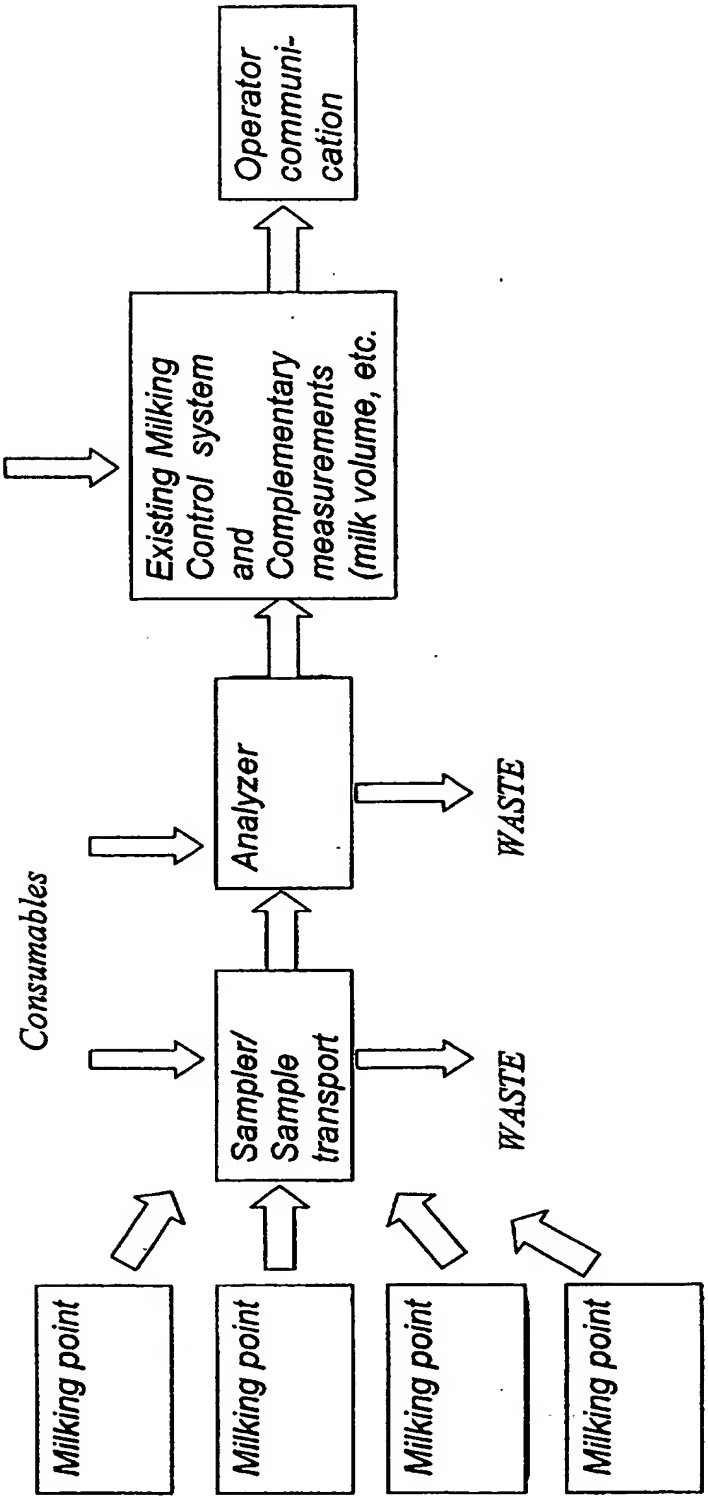

Milking point
Milking point
Milking point
Milking point
Consumables
Sampler/ Sample transport
WASTE
Analyzer
WASTE
Existing Milking Control system and Complementary measurements (milk volume, etc.
Operator communi-cation

Fig. 1

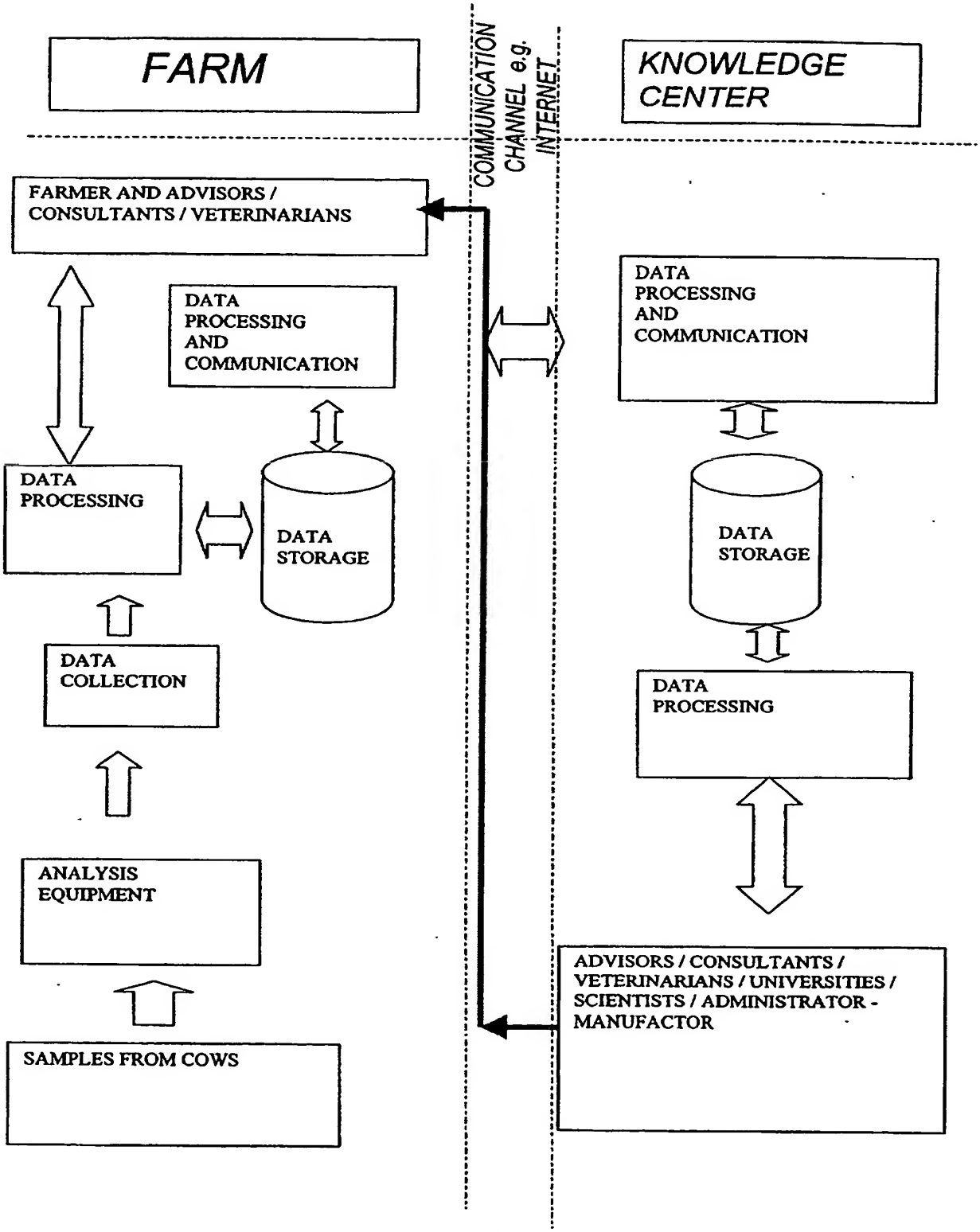
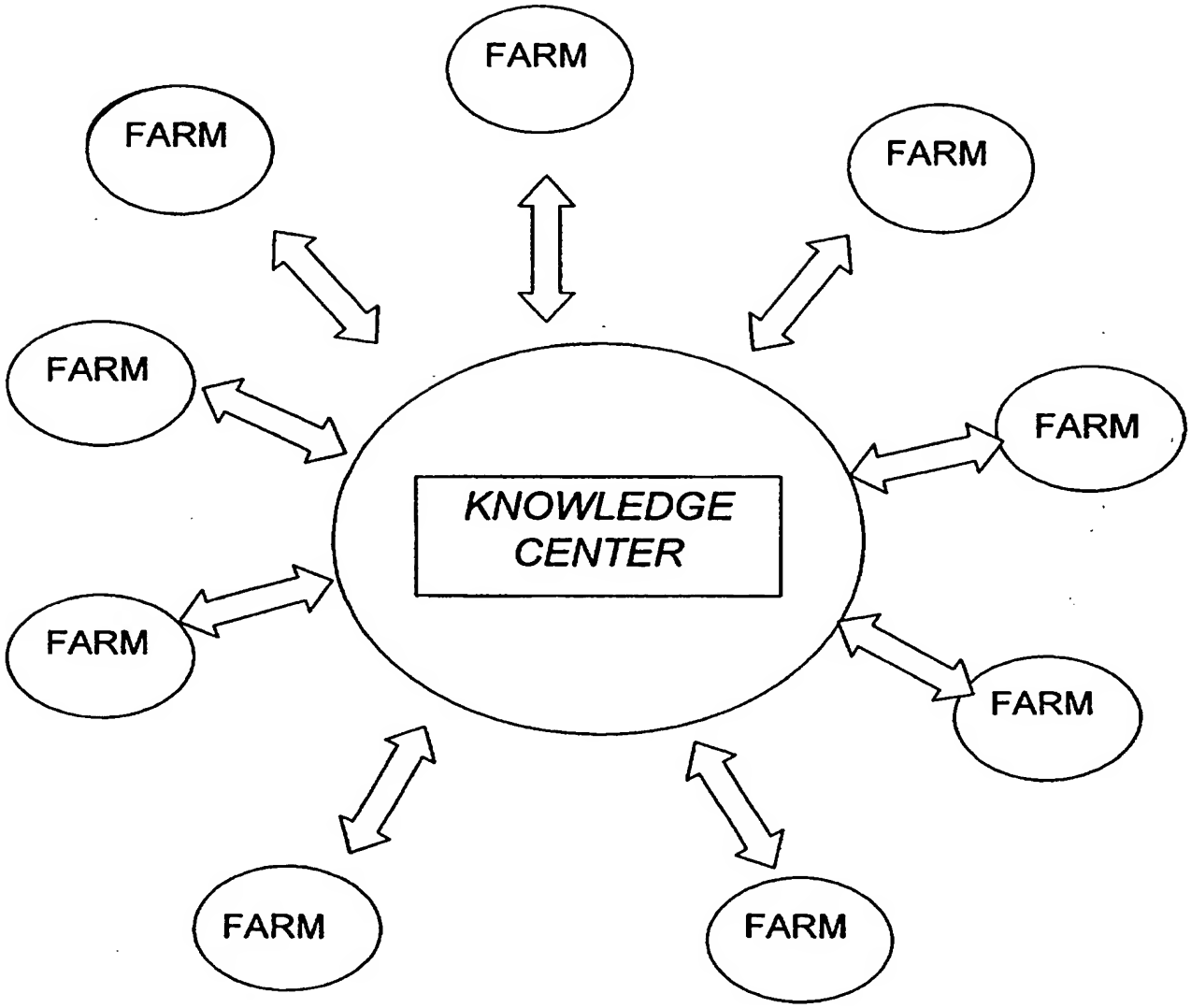

FARM
COMMUNICATION CHANNEL e.g. INTERNET
KNOWLEDGE CENTER
FARMER AND ADVISORS / CONSULTANTS / VETERINARIANS
DATA PROCESSING AND COMMUNICATION
DATA PROCESSING
DATA STORAGE
DATA COLLECTION
ANALYSIS EQUIPMENT
SAMPLES FROM COWS
DATA PROCESSING AND COMMUNICATION
DATA STORAGE
DATA PROCESSING
ADVISORS / CONSULTANTS / VETERINARIANS / UNIVERSITIES / SCIENTISTS / ADMINISTRATOR - MANUFACTOR

Fig. 2


FARM
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KNOWLEDGE CENTER
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Fig. 3

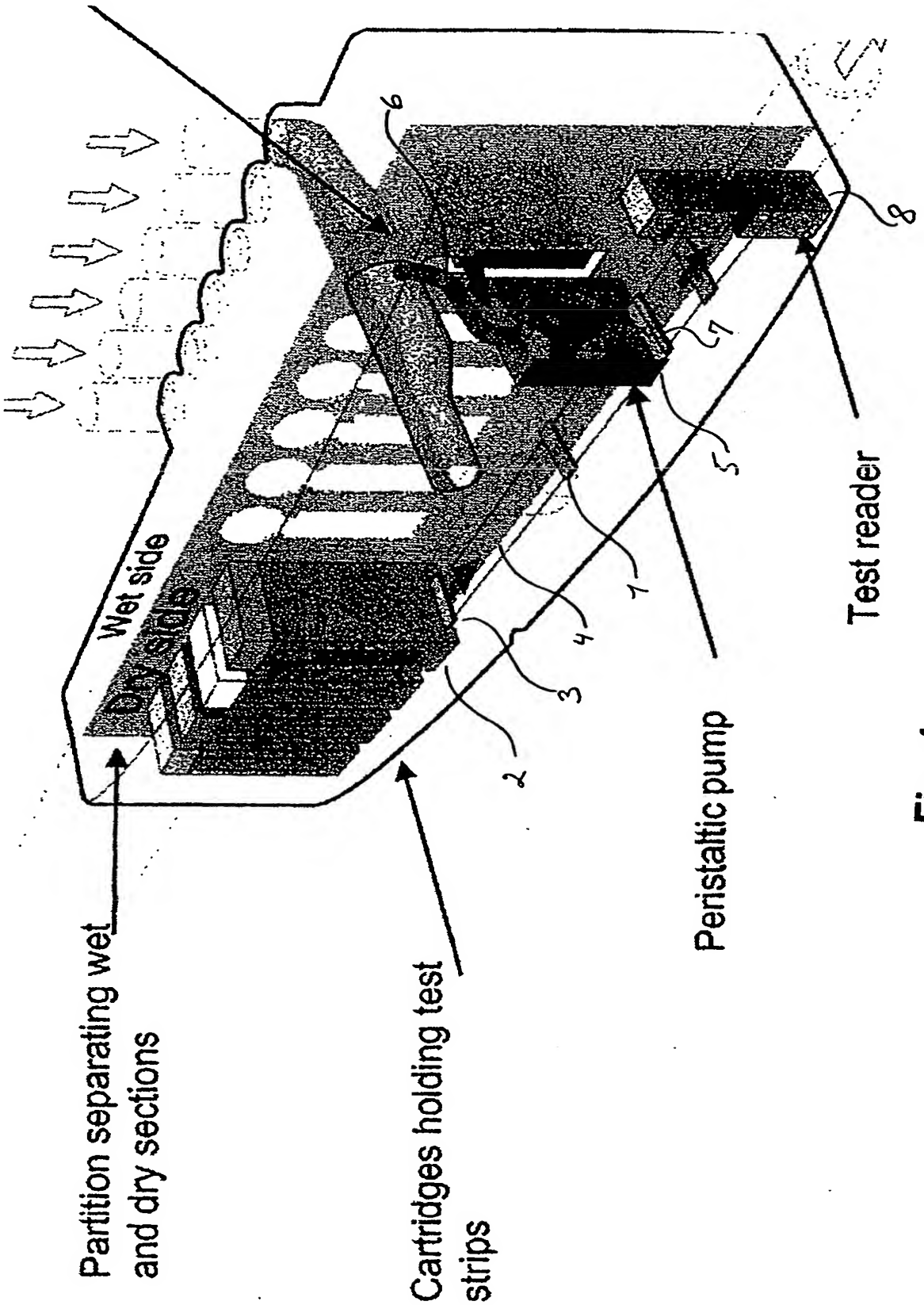
Wet side
Dry side
6
8
7
5
4
3
2
1
Partition separating wet and dry sections
Cartridges holding test strips
Peristaltic pump
Test reader

Fig. 4

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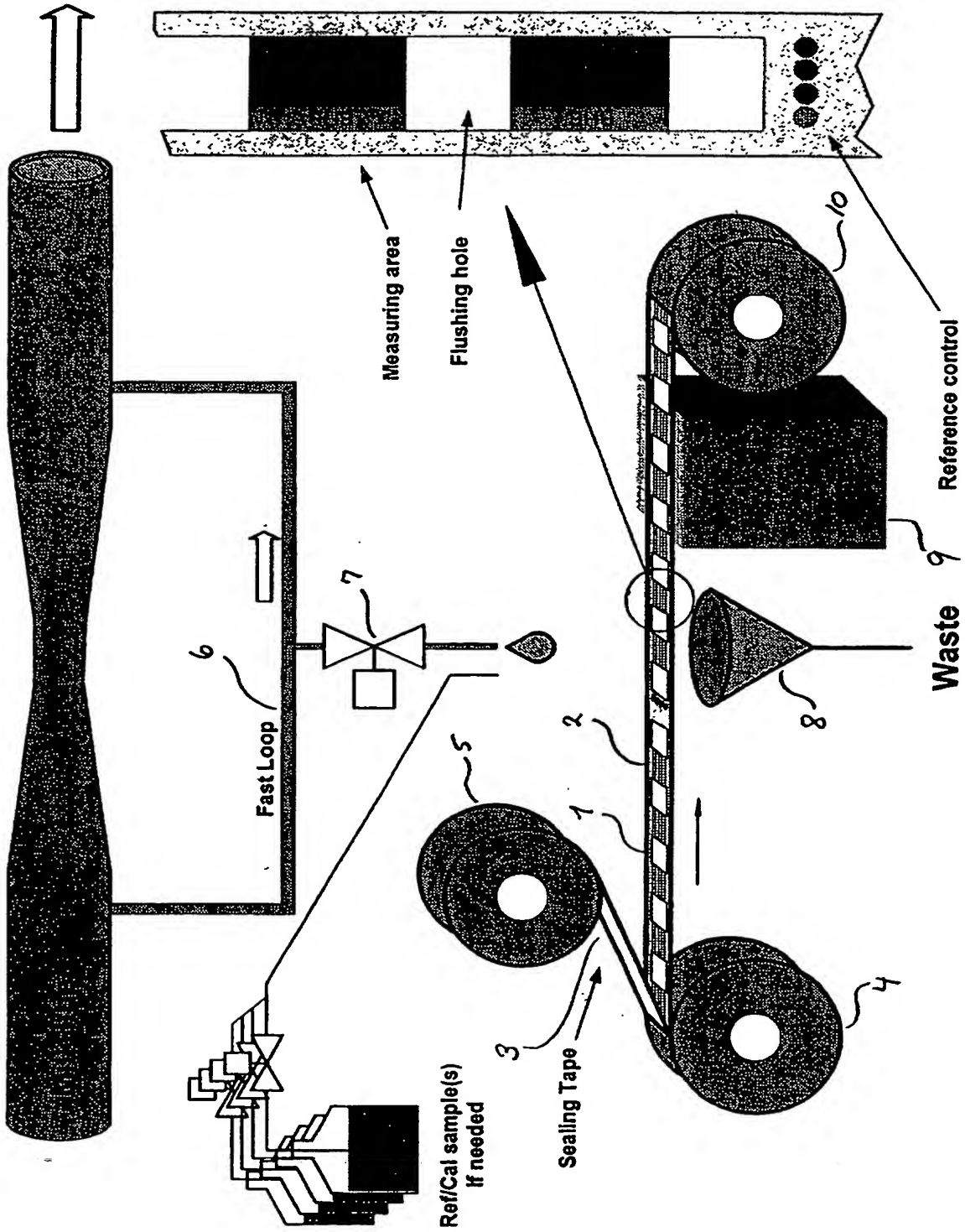
Measuring area
Flushing hole
Reference control
Waste
Fast Loop
Sealing Tape
Ref/Cal sample(s)
If needed
1
2
3
4
5
6
7
8
9
10

Fig. 5